Retrospective Analysis of Radiation Induced Necrosis after Stereotactic Radiosurgery in Patients with Metastatic Brain Lesions: Correlation of Volume and Dose Parameters and Incidence of Neurologic Sequelae

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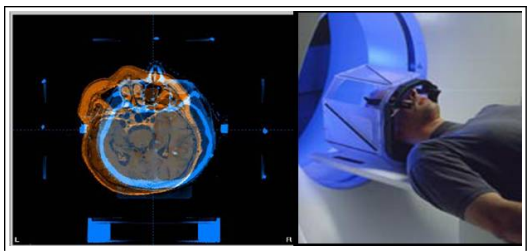
Introduction

Stereotactic Radiosurgery (SRS) is an effective treatment for neoplasms of the brain, especially metastatic lesions. SRS uses focused high dose radiation with sharp dose fall-off to provide a lower morbidity and mortality treatment option.

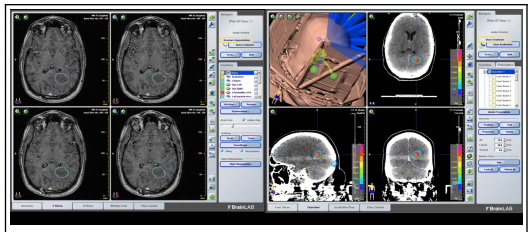
Thus, the goal of SRS is to balance effectively treating the lesion while limiting CNS toxicity to the surrounding normal brain. Several recent studies have looked at the incidence of radiation necrosis to the surrounding normal brain with occurrence rates ranging as high as 46%, but most studies quoting an average incidence of 25%. Most of the literature analyzing factors leading to radiation necrosis were derived from data on SRS treatment of arteriovenous malformations. Predictive factors for the development of radiation necrosis include patient factors such as location and size of the lesion, history of prior radiation, sex, chemotherapy history as well as radiation treatment parameters including total dose and volume, number of isocenters treated and conformity index. 14% of radiation necrosis lesions will be symptomatic and associated with some neurologic sequelae.



Acquisition and fusion of stereotactic data

Objective

To retrospectively determine predictive parameters for radiation necrosis from the dose-volume relationship in patients with metastatic intracranial lesions treated with SRS and evaluate differences in these dose-volume parameters for patients developing neurological complications.

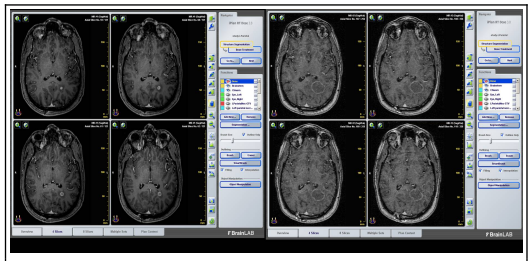


Treatment planning

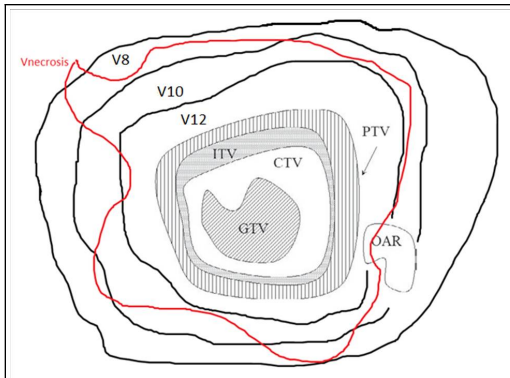
Materials and Methods

A single institution retrospective analysis from January 2007 – December 2010 was conducted. Patients who received cranial SRS were treated at the Einstein-Montefiore Cancer Center using a CRW frame-based LINAC system using BrainLab software and hardware. Inclusion criteria for the study were diagnosed extra cranial malignancy with documented metastatic intracranial disease, no lesions previously treated with SRS, and adequate follow up (2 – 29 months, median 10 months).

Radiation necrosis was based solely on MRI changes and included the size of enhancing area and peri-lesional T2 signal on post treatment MRI compared to pretreatment MRI. All imaging was reviewed by both Neurosurgery attending and senior resident as well as Radiation Oncology attending and senior resident. Follow up MR imaging was fused with the original treatment planning MRIs and the area of radiation necrosis was contoured and dose-volume calculations were performed with the original treatment plan. V8Gy, V10Gy, V12Gy as well as V100, D100 and conformity index of the original plan and tumor volumes were recorded. Neurologic exam at time when follow-up imaging revealed radiation necrosis was also recorded.



Pre and Post treatment



Schematic representation of radiation necrosis to calculated volume dose parameters

Results

127 patients were treated with SRS during the defined time period, 35 patients met the inclusion criteria. 74 total lesions were treated. Up to 6 discrete lesions were treated per patient, average of 2±1 lesions per patient. The average volume of lesion treated was 2.3±3.6cc, the average treating dose was 20.1±3.2Gy. The accepted mean treatment dosage ranged between 18-24Gy.

16 patients (23 lesions) of the original 35 patients developed radiation necrosis. The average size of the lesion that went on to develop radiation necrosis was 2.6±3.4cc and received an average treatment dose of 19.8±3.8Gy. 5 patients (31%) had symptomatic radiation necrosis. Their neurologic sequelae included hemiparesis, dysphonia, writing difficulties and gait disturbance. Grade 3-5 based on RTOG criteria.

The V8Gy, V10Gy, V12Gy were larger for the lesions that developed radiation necrosis. This difference was statistically significant (p=0.04). Comparing symptomatic radiation necrosis lesions to asymptomatic lesions, we found no statistical significance amongst the calculated V8Gy, V10Gy, V12Gy parameters, but we did find larger D100 values in patients with symptomatic necrosis lesion (10.3±5.0Gy compared to 5.8±4.0Gy). This difference was significant (p<0.04).

	Radiation Necrosis	No Radiation Necrosis
V8	17.1±18.1	8.4±5.8
V10	12.2±12.5	6.0±4.2
V12	8.9±9.1	4.4±3.0

Conclusions

In our patients higher V8Gy, V10Gy, V12Gy correlated with a greater risk of developing radiographic radiation necrosis. D100 correlated with a higher likelihood of developing symptomatic radiation necrosis. Since we included patients with multiple lesions and no retreatment, confounding variables such as co-morbid conditions, histology and concomitant therapies have less likelihood of affecting the analysis. Nonetheless, inclusion of these parameters in SRS planning is suggested.

References

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